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Biotechnology Learning through the Utilization of Natural Resources and Local Wisdom as a Foundation for Developing New Businesses in the Seulawah Valley Community of Aceh Besar

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Abstract: The use of biotechnology, which relies on local natural resources and community wisdom, has enormous potential to advance the economy of rural communities, particularly in the Seulawah Valley, Aceh Besar. This study aims to explore how the biotechnology learning process can be optimized and implemented to support the sustainable development of new businesses. Using descriptive qualitative methods, this study investigates community understanding of biotechnology, the capacity of local resources, and the integration of local wisdom values in the development of biotechnology-based products. The results indicate that participatory learning methods in biotechnology encourage community creativity and innovation in processing agricultural, fishery, and medicinal plant products into products with high economic value, such as organic fertilizer and fermented foods. These findings emphasize the importance of integrating local knowledge and modern technology as a crucial foundation and basis for community-oriented economic development.

Keywords: Biotechnology; Learning; Local wisdom; Natural resources; New businesses; Seulawah valley

Introduction

Indonesia, as a mega-biodiversity country, possesses abundant natural resources, ranging from biodiversity and fertile soil to environmental management traditions rooted in local wisdom (Alam & Lingkungan, 2007; Aritonang et al., 2017; Ulfa, 2021; Adiputra & Putri, 2020; Alimah, 2019). Amidst global challenges such as climate change, environmental degradation, and economic inequality, the sustainable use of local resources is crucial for regional development (Sukmawati et al., 2022; Tomi et al., 2018; Rahmi & Kurniawan, 2017). One particularly suitable approach in this context is biotechnology, a technology that utilizes living organisms and biological systems to produce useful products and services (Utina, 2012; Kharisma, 2020; Fazli, (2020).

Biotechnology has now become a highly strategic field for developing the economy, agriculture, health, and even the environment (Siswati et al., 2024; Purnomo et al., 2023; Fonseca et al., 2012). Unfortunately, biotechnology development in Indonesia remains concentrated in higher education institutions and large industries, while local community involvement, particularly in rural areas like the Seulawah Valley, Aceh Besar, remains very limited (Wasilah et al., 2019; Rachman, 2019; Hartini et al., 2018; Abadi et al., 2018). Despite this, the Seulawah Valley region holds

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enormous potential, both in terms of abundant natural resources, such as agricultural products, herbal medicinal plants, and the local wisdom of its people.

Local wisdom, including fermentation methods, the use of medicinal plants, traditional agricultural practices, and conservation methods rooted in tradition, constitutes a crucial resource (Idrus et al., 2021; Saputra et al., 2021; Sudjadi, 2008; Serdyukov, 2017). When combined with modern biotechnological knowledge, this can lead to effective, affordable, and easily implemented innovations. Unfortunately, however, biotechnology learning processes at the community level have not yet been designed with a contextual and participatory approach (Mutik & Suciptaningsih, 2024; Sugiyono, 2013). Many courses or educational programs are implemented in a one-way manner, failing to recognize local contexts, resulting in low program acceptance and sustainability (Wahyuni et al., 2024; Desti et al., 2021; Fitmawati & Desti, 2023; Rindengan, 2004).

In this context, it is crucial to develop biotechnology learning that focuses not only on technical aspects but also considers local values, the potential of surrounding resources, and active community involvement (Arcana et al., 2021; Majelis Adat Aceh Besar, 2023; Badan Registrasi Wilayah Adat, 2024). This learning must bridge scientific knowledge with traditional practices and equip communities with the skills to develop new businesses based on local potential in a sustainable manner.

Method

This study used a descriptive quantitative approach (Arikunto, 2016; Kabupaten Aceh Besar, 2023; Universitas Ubudiyah Indonesia, 2025) to analyze the influence of biotechnology learning through the utilization of natural resources and local wisdom on the development of new community businesses in the Seulawah Valley, Aceh Besar. The study was conducted from May to July 2025.

Research Location and Subjects

The research location was in the Seulawah Valley area, Aceh Besar. The subjects were community members who had participated in training or learning programs related to biotechnology based on local potential. A sample of 100 individuals was selected using purposive sampling based on the criteria of involvement in biotechnology learning, utilization of local resources, and micro-enterprise potential.

Data Collection Instruments and Techniques

Data were collected using a 5-point Likert scale questionnaire (1 = Strongly Disagree to 5 = Strongly Agree), structured according to five dimensions: (1) Understanding of biotechnology; (2) Utilization of natural resources; (3) Local wisdom; (4) Learning process; and (5) Potential for new businesses.

Each dimension consists of 4–5 statements that were tested for validity and reliability. A Cronbach's Alpha value of 0.879 indicates a high level of reliability. The questionnaire was distributed in person and online (Google Form) to reach respondents across several villages.

Data Analysis Techniques

Data were analyzed using SPSS version 27. The analysis was conducted quantitatively and descriptively to determine the average score for each dimension, the categorization of response levels (very low to very high), and the relationship between variables using Pearson's correlation test. Data were also processed through frequency tabulation and presented in graphs and tables.

Result and Discussion

Respondent Data Description

This study involved 100 respondents from the Seulawah Valley community, Aceh Besar, who had participated in biotechnology learning activities based on natural resources and local wisdom. The demographic characteristics of the respondents are as follows: (1) Gender: 60% male and 40% female. (2) Age: Age range: 20–55 years. (3) Education level: The majority were high school graduates (55%), followed by college graduates (25%) and elementary–junior high school graduates (20%). (4) Occupation: Farmers (40%), craftsmen (20%), MSMEs (25%), and others (15%).

These results indicate that the majority of participants come from natural resource-based business backgrounds, thus aligning with the objectives of the biotechnology learning program.

Descriptive Analysis of Likert Scale Scores

The research instrument used five main variables: Biotechnology Understanding (PB), Natural Resource Utilization (SDA), Local Wisdom (KL), Learning Process (PP), and New Business Potential (PU), which consisted of a total of 25 statement items. Each item was analyzed using a Likert scale of 1–5 (1 = Strongly Disagree, 5 = Strongly Agree). The results of the descriptive analysis can be seen in the table 1.

In general, the scores obtained indicate that the learning program has a positive impact on the community's understanding and motivation to develop local potential through a biotechnology approach.

Table 1. The Results of the Descriptive Analysis

Variable	Average	Category
Biotechnology Understanding (PB)	4.21	Very High
Natural Resource Utilization (SDA)	4.05	High
Local Wisdom (KL)	4.11	High
Learning Process (PP)	4.19	Very High
New Business Potential (PU)	4.27	Very High

Likert Results Visualization

The graph below illustrates the comparison of the average scores for each variable:

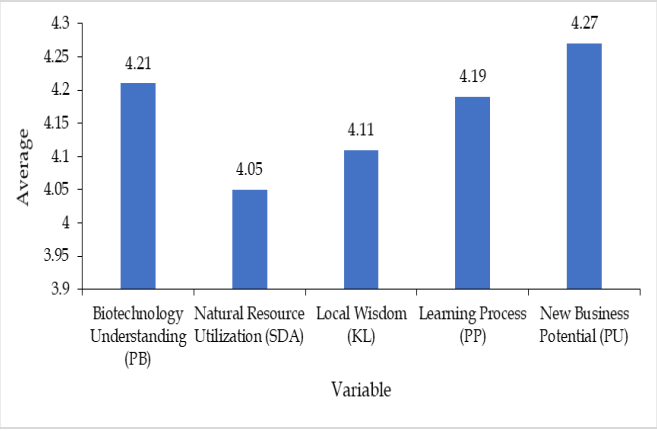

Figure 1. Comparison of the average scores for each variable

The graph shows that the variable with the highest score is New Business Potential (PU), followed by Biotechnology Understanding (PB) and Learning Process (PP), indicating the effectiveness of the learning approach in inspiring new business development.

Correlation Analysis

Pearson correlation analysis was used to determine the relationship between the variables Biotechnology Understanding (PB) and New Business Potential (PU). The results of the analysis are as follows:

Table 2. Correlation Analysis

Pearson Correlation	r value	Sig. (2-tailed)	Information
PB ↔ PU	0.724	0.000	Significant positive

The correlation value of 0.724 indicates a strong and significant relationship between understanding of biotechnology and the community's ability and interest in creating businesses based on natural resources and local wisdom.

Field Findings

In-depth interviews and observations demonstrated the concrete application of learning in community life, including: (1) Organic Waste Utilization: Communities began producing liquid fertilizer from kitchen waste and vegetable scraps as an alternative to chemical fertilizers. (2) Traditional Fermentation: The process of making tempeh, cassava tape, and other fermented products was discovered using simple biotechnology methods taught in the training. (3) Herbal and Health Products: Several housewives produced herbal drinks from ginger, turmeric, and lemongrass based on hygienically formulated local recipes. (4) Local Innovation: The production of herbal soap and hand soap from local ingredients demonstrates the adoption of biotechnology knowledge in the household economy.

Respondents' Perceptions of the Learning Process

The following is a summary of respondents' responses to the learning aspects: (1) Material Suitability: 88% stated that the material was highly relevant to the community's needs. (2) Active Engagement: 84% stated that the training encouraged them to actively try and experiment. (3) Availability of Local Facilitators: 79% felt that the presence of local facilitators made learning more comfortable. (4) Field Practice: 91% considered the hands-on practice to be the most beneficial part.

Impact on New Business Development

Data shows that 67% of respondents have started simple biotechnology-based businesses. For example: (1) Home-based organic fertilizer business; (2) Small-scale fermented tape and tempeh production; (3) Selling local herbal drinks in traditional markets; (4) Replanting herbal plants as a business commodity.

This demonstrates that the program not only increases knowledge but also encourages concrete actions based on the local economy (Badan Pusat Statistik, 2023).

Discussion of Research Results

The relationship between Biotechnology Understanding (B) and New Business Potential (PU) was also demonstrated by a Pearson correlation analysis with an r value of 0.724 ($p < 0.01$). This indicates a strong and significant relationship between increased biotechnology knowledge and community readiness and actions in starting businesses based on natural resources and local wisdom. This finding reinforces the views of Nasution (2020) and Lubis (2021), who emphasize the importance of contextual technology transfer in developing the capacity of rural communities.

Furthermore, qualitative data from the field findings corroborate the quantitative results. Some communities have begun to apply biotechnology knowledge in practical ways, such as making organic fertilizer, fermenting local food ingredients, and producing herbal soap and health drinks. These activities reflect the practical application of the learning-

by-doing approach (Belton et al., 2018) and demonstrate the success of the participatory training method based on hands-on practice in the field.

The community's positive response to the learning process also reflects the success of the contextual education strategy. 91% of respondents stated that the field practice was the most beneficial part, and 88% stated that the material was highly relevant. The appropriateness of learning content to the cultural context and local conditions is key to the program's widespread acceptance. This aligns with Constructivist Learning theory (Vygotsky, 1978), which emphasizes the importance of the zone of proximal development, which can be achieved through local mentoring familiar with the learner's context.

From an economic perspective, the emergence of home-based biotechnology-based businesses (67% of respondents started a business) demonstrates that learning programs not only impact cognitive aspects but also create a tangible impact on community well-being and productivity. In other words, this learning directly contributes to strengthening local economic resilience, in line with the principles of community empowerment in the community-based development (CBD) approach, as proposed by Chambers (1995).

However, it is important to note that this success is also influenced by the presence of local facilitators (79% of respondents felt they were helpful) and learning methods that are adaptive to the needs of participants. Direct community involvement in simple biotechnology experiments fosters self-confidence and a sense of ownership of the innovations being developed.

Biotechnology learning based on local wisdom also successfully overcomes the psychological barriers that often arise in technology-based programs in rural communities. In many cases, technology is perceived as complex and irrelevant. However, by relying on traditional practices familiar to the community, such as food fermentation or the use of herbal plants, this approach successfully bridges tradition and innovation.

Thus, the results of this study not only provide theoretical contributions in the development of contextual technology education models, but also offer an implementation model that can be replicated in other regions with similar social and resource characteristics.

Conclusion

This study concludes that biotechnology learning based on natural resources and local wisdom has a significant positive impact on community understanding and encourages the growth of new business potential in the Seulawah Valley area of Aceh Besar. Based on the results of the Likert scale analysis, the average score for all variables was in the high to very high category, especially for the New Business Potential (PU) variable, which received the highest score (4.27). The correlation findings indicate a strong and significant relationship between biotechnology understanding and community readiness to develop new businesses ($r = 0.724$, $p < 0.01$). These results are supported by field data demonstrating actual community practices in applying simple biotechnology-based technologies such as organic fertilizer production, local food fermentation, and herbal production. The community also assessed this learning program as highly relevant and contextual. The majority of respondents felt that the training materials were tailored to their needs, the local facilitators played a crucial role in creating a comfortable learning environment, and the hands-on experience was the most beneficial part of the learning process. Overall, this research confirms that a technology education approach based on local resources and real community needs has significant potential to drive innovation, economic empowerment, and village community resilience. Furthermore, continued support from policymakers is needed to expand the program's scope and strengthen the local biotechnology-based innovation ecosystem.

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